Canada AGRI-FOOD ECONOMIC & REGIONAL DEVELOPMENT AGREEMENT Manitoba

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Crop Management Facts

Nitrogen Fertilization of the Newer Wheat Varieties — Semidwarf and Hard Red Spring Varieties

Determining nitrogen fertilizer rates is one of the most important management decisions faced by Manitoba wheat producers each year. While adequate nitrogen supplies are needed for good yields and quality, using too much nitrogen fertilizer can reduce the overall profitability of a cereal crop.

Nitrogen recommendations developed during the 1960s and 1970s have been a valuable tool for setting optimum fertilizer rates. However, the recent introduction of new grain varieties has raised an important question: How relevant are these recommendations for newer cultivars, such as the semidwarf wheats?

In 1985, Agriculture Canada initiated a study at the Brandon Research Station to investigate how six of these newer wheat varieties respond to different nitrogen levels. The cultivars used in the study were Katepwa (a standard height variety), Glenlea (a standard height feedwheat), Len, HY320, Marshall and Solar (all semidwarf wheats). (See Table 1.)

The three-year study was conducted on a wide range of soils in central and southwestern Manitoba (Table 2) in co-operation with the Western Fertilizer and Chemical Dealers Association and with funding from the Agri-Food agreement. The results of these trials were compared with the four "target yield" curves that are the basis for the nitrogen recommendations now used in the soil testing program.

The major findings of this study are summarized here, along with some general guidelines for nitrogen fertilization.

TABLE 1

Wheat Varieties Used in the 1985-87 Wheat Trials

VARIETY	SOURCE	HEIGHT	TYPE
Glenlea	University of Manitoba, 1972	Standard	CU
HY320	Agriculture Canada, Swift Current, 1984	Semidwarf	CPS
Katepwa	Agriculture Canada, Winnipeg, 1984	Standard	CWRS
Len*	North Dakota State University, 1979	Semidwarf	US HRS
Marshall*	Minnesota State University, 1982	Semidwarf	US HRS
Solar*	Agsco, Minnesota, 1978	Semidwarf	US HRS

* Unregistered American varieties, not eligible for Canadian Wheat Board CWRS, CPS or CU grades.

TABLE 2

Site and Soil Information for the Wheat Trials

SITE & SOIL	PREVIOUS CROPS			AVAILABLE NITRATE-NITROGEN TO 60 CM (24 IN.) KG/HA (LB./ACRE)		
	1985	1986	1987	1985	1986	1987
Minnedosa (Newdale clay loam)	Barley	Canola	Flax	22 VL (20)	35 M (31)	22 VL (20)
Souris (Souris fine sandy loam)	Wheat	Canola	Canola	23 VL (21)	32 L (29)	28 L (25)
Miami (Altona fine sandy loam)	Corn	Canola	Corn	26 L (23)	49 M (44)	53 M (47)

Note: Nitrogen level: VL = very low, L = low, M = medium

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Yield Response to Moisture Conditions

Field trials conducted during the 1960s and 1970s showed nitrogen fertilizer generally has a greater effect on wheat yields as soil moisture increases (Figure 1). Therefore, existing soil testing guidelines suggest using greater amounts of fertilizer in areas of the province with higher average precipitation or on soils with a high water-holding capacity.

How the newer varieties compared: According to the results of the 1985-87 study, this relationship between nitrogen use and moisture is also valid for the newer wheat varieties. The response curves for the "dry" and "moist" soil categories showed response to nitrogen supply was enhanced as available moisture increased for these newer varieties, particularly with semidwarf wheats.

The study results suggest current nitrogen recommendations can be followed for Katepwa and other standard height varieties, as well as for the feed wheat Glenlea and the semidwarf Len. Under both moist and dry conditions, the nitrogen response curves for the new hard red spring variety Katepwa were similar to the target yield curves now used for soil test recommendations (Figure 2), until the nitrogen supply reached 100 kg/ha (90 lb./acre). When the nitrogen supply was greater, the yields of Katepwa under both moist and dry conditions decreased while the target yield curves levelled off. The response in yield to nitrogen supply of the varieties Glenlea and Len was similar to Katepwa (Figures 3 and 4).

In both dry and moist conditions, the semidwarf variety HY320 outyielded Katepwa at all nitrogen supply levels (Figure 5) by an average of 33 per cent. The nitrogen response curves for the three semidwarf varieties HY320, Solar and Marshall were similar in dry and moist soil conditions (Figures 6 and 7). In the Provincial Soil Testing program the yields of these three semidwarf varieties at any given nitrogen supply will therefore be projected to be 33 per cent higher than the hard red spring wheat.

Marginal Cost-Return

What nitrogen fertilizer rate will provide the best dollar return with relatively low risk?

To answer this question, grain producers must take several factors into account, including the nitrogen levels in the soil at the start of a growing season. When soils are low in nitrogen, a small amount of nitrogen fertilizer can cause a significant increase in yields and, in turn, profits. However, at higher levels of soil nitrogen, the addition of fertilizer will have a less dramatic effect on yields and could therefore be less cost-effective.

Soil moisture, grain prices and fertilizer prices must also be considered. As these factors vary from year to year, the fertilizer rate needed for optimum returns will also vary.

As a general rule of thumb, economist say farmers should aim for a return of $1.50 for every $1.00 spent on nitrogen fertilizer. In other words, the ratio of marginal cost to marginal return (MC:MR) should equal 1.5. This ratio will provide the farmer with a good return, while allowing for unpredictable yield variations or changes in market conditions which would jeopardize economic returns.

How the newer varieties compared: Table 3 (see back page) shows the nitrogen supply levels required to attain an MC:MR ratio of 1.5 for newer wheat varieties during the 1985-87 trials. From this data it is evident that semidwarf wheats produce higher yields more economically than traditional wheat cultivars even at higher nitrogen supply levels. The study suggests an additional nitrogen supply of 10 kg/ha (9 lb./acre) or 20 kg/ha (18 lb./acre) fertilizer is needed to optimize semidwarf production under **moist soil conditions**. Under **dry soil conditions**, however, the nitrogen supply requirement of semidwarf varieties is between 5 to 10 kg/ha (4 to 9 lb./acre) or 10 to 20 kg/ha (9 to 18 lb./acre) greater than for standard varieties, depending on the cost-price situation.

Optimal nitrogen supply levels depend on the price of grain, as higher grain prices may make higher nitrogen rates economical. This is seen when comparing optimal nitrogen supply levels at a suggested low and high grain price.

Protein

How the newer varieties compared: Table 4 (see back page) compares the grain protein levels of the different cultivars at different fertilizer rates used in the study. Generally, the grain protein content of semidwarf wheats is lower than that of either Glenlea or Katepwa, particularly under higher moisture conditions. However, the semidwarf varieties produced more total grain per hectare (acre) than Katepwa or Glenlea because of the higher yields, particularly at higher nitrogen levels.

Nitrogen and Soil Type

As mentioned previously, soil moisture and texture are crucial factors in determining optimum fertilizer rates. Knowing whether soil in the area is classified as arid, dry, moist or ideal (irrigated) helps determine yield potential. Less nitrogen fertilizer is generally recommended for soils prone to periods of drought, such as coarse soils in the southwest corner of the province.

An assessment of spring soil moisture also helps adjust nitrogen rates. Lower rates should be used under dry spring conditions, particularly on coarse sandy soils with low water-holding capability.

Producers can ensure all of these factors are taken into account by submitting a soil sample to the Provincial Soil Testing Laboratory. The laboratory automatically classifies all samples into the appropriate moisture categories using criteria such as soil texture, drainage and legal location. Nitrogen recommendations are then based on this moisture category and on the requirements of the crop to be seeded.

Figure 2: Response of Katepwa to Nitrogen During Dry and Moist Growing Conditions

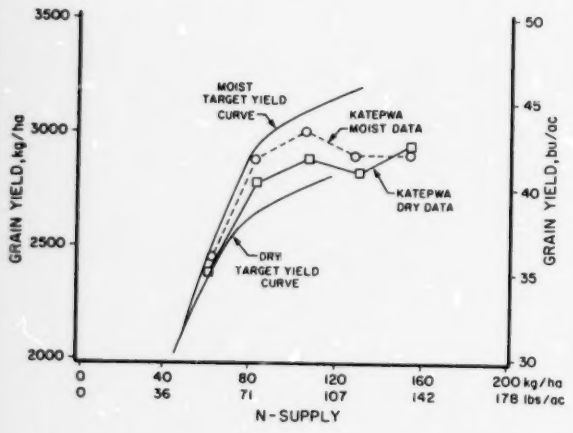

GRAIN YIELD, kg/ha
GRAIN YIELD, bu/ac
MOIST TARGET YIELD CURVE
KATEPWA MOIST DATA
KATEPWA DRY DATA
DRY TARGET YIELD CURVE
N - SUPPLY
0 40 80 120 160 200 kg/ha
0 36 71 107 142 178 lbs/ac

Figure 3: Comparing the Response of Glenlea, Len and Katepwa to Nitrogen Under Dry Growing Conditions

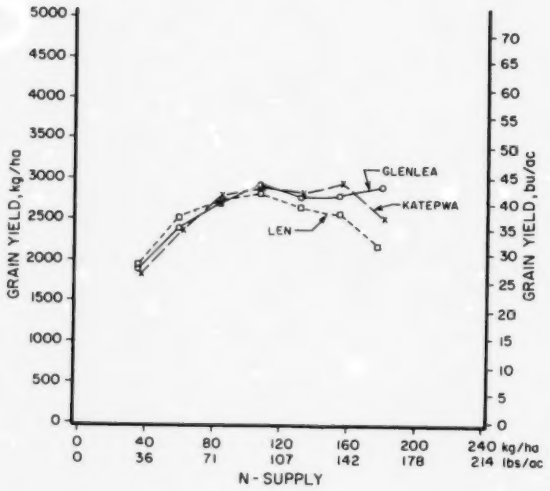


Figure 4: Comparing the Response of Glenlea, Len and Katepwa to Nitrogen Under Moist Growing Conditions

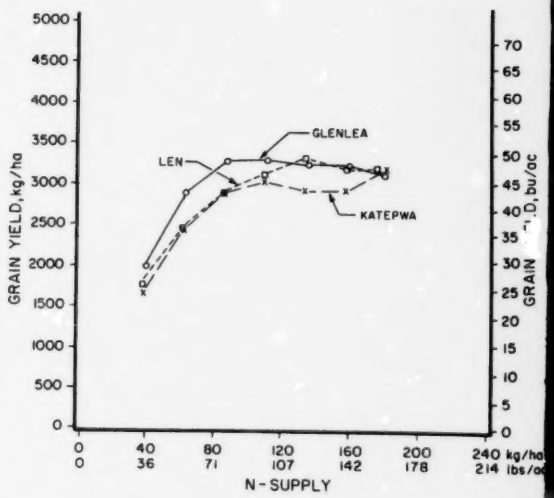


Figure 5: Nitrogen Response of HY320 and Katepwa During Dry and Moist Growing Conditions

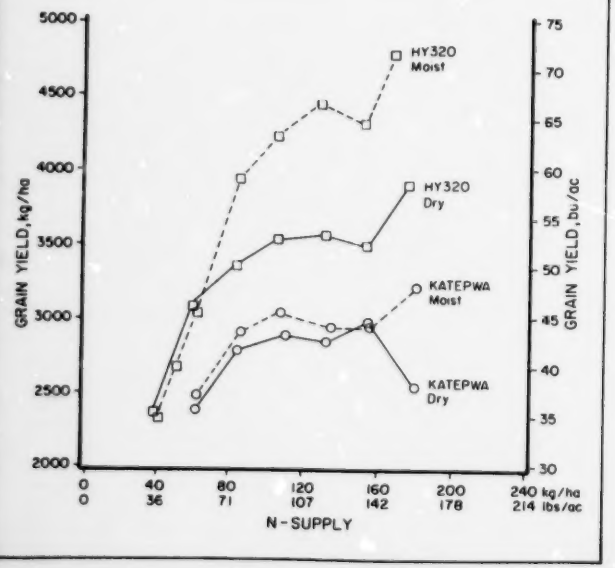


Figure 6: Comparing the Response of HY320, Solar and Marshall to Nitrogen Under Dry Growing Conditions

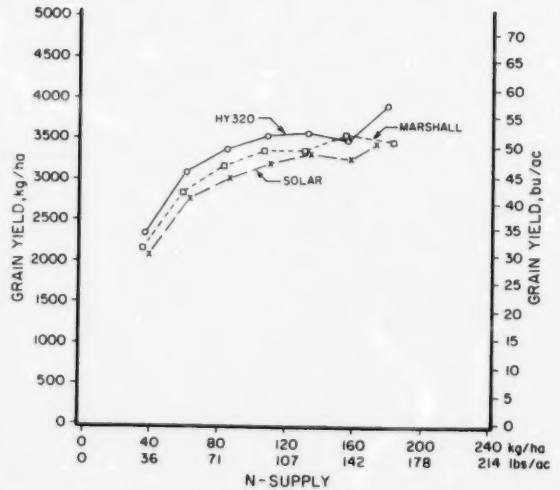


Figure 7: Comparing the Response of HY320, Solar and Marshall to Nitrogen Under Moist Growing Conditions

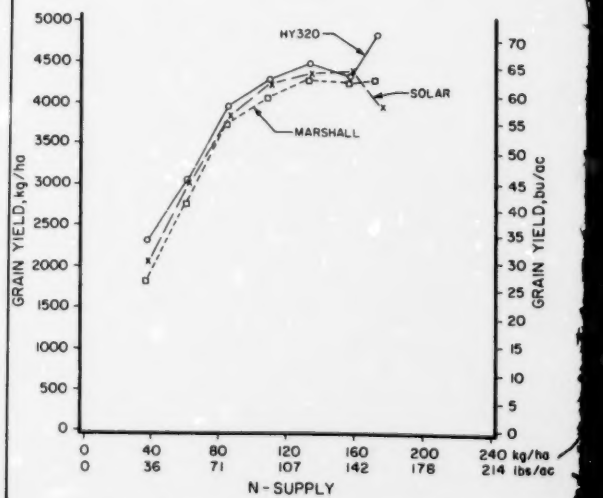
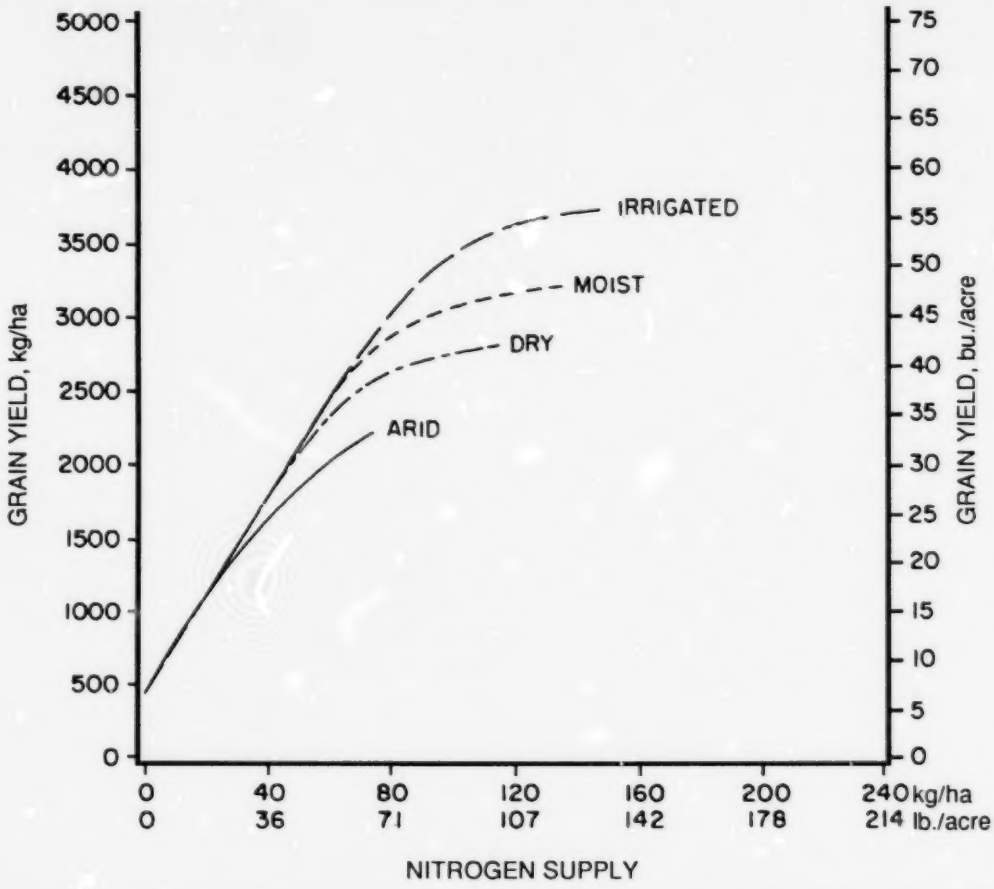


Figure 1: Manitoba Target Yield Curves for Wheat



Definition of Terms

Nitrogen supply was defined as soil nitrate nitrogen content to a depth of 60 cm (24 in.) plus fertilizer nitrogen adjusted to account for the "efficiency of recovery" of the applied fertilizer nitrogen. (The efficiency of nitrogen fertilizer band applied in spring is considered to be 60 per cent.)

At the start of the trials, all sites were soil sampled to a 60 cm (24 in.) depth to determine soil nitrate levels before seeding. In 1985, seven rates of nitrogen fertilizer provided a nitrogen supply ranging from 0 to 240 kg/ha (214 lb./acre). In the 1986 and 1987 trials, supply ranged from 0 to 200 kg/ha (178 lb./acre). Nitrogen fertilizer was sideband applied as urea (46-0-0).

Irrigated Soils – Moisture not considered to be limiting.

Moist Soils – These are the soils which have high water-holding capacities, and/or are in the cooler soil areas but are subject to periodic dry conditions. Included are the Red River Valley clays and the Gray Wooded soils.

Dry Soils – These soils are intermediate in water holding capacity and are subject to dry weather conditions. Included are the medium textured soils in the southwest region.

Arid Soils – These soils have a poor ability to hold water and are subjected to dry conditions on a regular basis. Included are the coarse textured, well drained soils.

TABLE 3

Nitrogen Supply Levels Needed for a Marginal Rate of Return Greater Than or Equal to 1.5 (Based on 1985 – 1987 wheat data).

VARIETY AND SOIL MOISTURE	N SUPPLY KG/HA (lb./acre)	EXPECTED YIELD kg/ha (bu./acre)	N SUPPLY KG/HA (lb./acre)	EXPECTED YIELD kg/ha (bu./acre)
Katepwa	price = $128/tonne ($3.50/bu.)		price = $165/tonne ($4.50/bu.)	
dry soil	75 (67)	2575 (38)	80 (71)	2625 (39)
moist soil	90 (80)	2975 (44)	100 (89)	3075 (46)
Glenlea	price = $101/tonne ($2.75/bu.)		price = $147/tonne ($4.00/bu.)	
dry soil	75 (67)	2700 (40)	80 (71)	2750 (41)
moist soil	90 (76)	3450 (51)	100 (89)	3525 (52)
HY320	price = $110/tonne ($3.00/bu.)		price = $147/tonne ($4.00/bu.)	
dry soil	80 (71)	3500 (52)	90 (80)	3575 (53)
moist soil	100 (91)	4075 (61)	110 (98)	4150 (62)

Nitrogen price = $0.55/kg ($0.25/lb.)

TABLE 4

Grain Protein Levels of Katepwa, Glenlea and HY320 with Dry and Moist Soils and Increasing Fertilizer Rates

NITROGEN FERTILIZER RATE		PER CENT PROTEIN					
		KATEPWA soil moisture		GLENLEA soil moisture		HY320 soil moisture	
kg/ha	(lb./acre)	dry	moist	dry	moist	dry	moist
0	(0)	13.5	14.4	12.6	12.2	12.2	11.2
40	(37.5)	13.3	14.3	12.9	12.4	12.3	11.0
80	(71.4)	15.0	14.7	14.3	12.9	13.1	11.3
120	(107.2)	15.7	16.1	14.8	13.8	14.0	11.9
160	(142.9)	16.4	16.9	15.2	15.0	14.5	12.5
200	(178.6)	16.4	17.2	15.7	15.8	15.0	12.9

For more information on soil testing, contact your agricultural representative or the Provincial Soil Testing Laboratory, 262 Ellis Building, University of Manitoba, telephone: 474-8154.

Information prepared by:

D. Gehl
E. Gauer
Agriculture Canada
Brandon, Manitoba

In co-operation with:

K. McGill
J. Ewanek
Manitoba Agriculture
Winnipeg, Manitoba